

UAV for Surveillance and Mapping at Construction Sites

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ABSTRACT

With the enhancement of technology and with the use of Artificial Intelligence in Machines Machine intelligence and learning has made its way to be one of the major field in Engineering and Technology. Drones are being rapidly used in each field soon these are going to be implemented in the field of construction and mining. The use of drones in the field of construction could be beneficial as it could serve various purposes. The proposed system will help in effective construction field as it could be used as surveillance system in the area where surveillance by humans is not possible. There are various cases of people dying in land mines or falling from buildings at construction sites, these can be reduced if there is a proper surveillance system in these areas. The proposed work will be helpful in construction areas to be used as a surveillance system. The proposed system is basically a drone can also be used for examining the areas where the construction is going to happen as it can help the workers to prepare in advance for the conditions at the site. It uses facial recognition for the surveillance of the workers at construction sites and also generates 3D models from the image taken by the drone. The drone is operated by a remote and would be equipped with a camera and digital processing unit for image processing.

Keywords: Drone; Constructional sites; unmanned aerial vehicle

I. INTRODUCTION

Due to the advancement in technology and use of Artificial Intelligence in the field of Machine, machine learning and the use of machines in various fields has increased in past few decades. One of the important features of advancement of technology is the use of drones in variety of fields. A quadcopter is an unmanned aerial vehicle that consists of four motors. Due to variety of features of quadcopters and its recent uses in variety of fields it has become the area of research and interest of variety of people.

The quadcopter nowadays is of variety of design and is completely different to the traditional quadcopters that consisted of only one motor which was used to provide the thrust and throttle to the quadcopter. The design of quadcopter nowadays consists of four motors that are used to provide the thrust to the quadcopter.

The design consisting of four motors is better than the design consisting of one motor as in four motors equal weight is carried by each motor and the whole weight is not on one motor.

The identical sets of two propellers are used in quadcopter. The sets of propellers that have rotation in clockwise direction are placed on the opposite sides of the frame while the other sets of propellers that have rotation in the anticlockwise direction are placed on opposite side.

The motors of the quadcopter are designed in such a way that two of them rotate in same direction and other two rotate in other direction. This is done because if all the motors i.e. all the propellers rotate in same direction than net moment about the center of mass would be non zero and the quadcopter would

rotate parallel to axis of motors and which would result in crashing of quadcopter.

The first drone was made in 2002 for military purpose since then drones have become the area of research and invention. With the advancement of technology the quadcopters were seen as a solution to vertical flight problems and was easy to construct.

The simple structure of the quadcopter has made it very popular in unmanned aerial vehicle research. The stabilization of the quadcopter is done using electronic systems and sensors, normally using GPS and gyro so that the quadcopter automatically judges its plan of flight and can be helpful in long run.

The various advantages of quadcopter are: Firstly it is cheap and convenient. Secondly it is simple in. Secondly they are also available in small size. Thirdly, the motors used in drone are small in size thus reduces the cost of damage.

II. LITERATURE SURVEY

Different papers suggested different methods for the uses of unmanned aerial vehicle in different fields. With the advancement in technology there are various additional features that can be added to the drones. Various new features were added to these UAV and as a result these if implemented can be proved to be very useful.

For the analysis of the landscape Noppakorn and Nottaphong suggested a method in their paper "Landscape analysis using 3D stereoscopic for drone". In this paper a method was suggested for the analysis of land using cross correlation.^[1]

Sandra Jakob et Al. in the paper "Processing Of Drone-Borne Hyperspectral Data for geological Applications" proposed a system that uses the data collected by the drone for geological applications .As

most of the drones now are used for surveillance purposes so this paper uses the data collected for drone for geological purposes.^[2]

Victor M. D. M. Leite et Al. in the paper "Testbed Prototype of an Unmanned Aerial Vehicle Design" provided the mechanism and the underlying principle in the construction of Unmanned Aerial Vehicles.^[3]

Y. Lozano et Al. in the paper "Design and Control of a Four-Rotary-Wing Aircraft" shows a methodology in the design of quadcopter. It represented the aerodynamics and various other aspects involved in the construction of quadcopter.^[4]

Kiran Kumar and Vinay Kumar Mittal in the paper "Accurate and Augmented Navigation for quadcopter based on Multi-Sensor Fusion" proposed a navigation system consisting of sensors for the aerial coordinates and orientation using a quadcopter.^[5]

Nikolaos Passalis et Al. in their paper "Concept Detection and Face Pose Estimation Using Lightweight Convolutional Neural Networks for Steering Drone Video Shooting" propose a system that can be used to capture video through Unmanned Aerial Vehicle (UAV) using deep learning techniques.^[7]

Maria Tzelepi and Anastasios Tefas in their paper "Human Crowd Detection for Drone Flight Safety Using Convolutional Neural Networks" propose a system that can be used to distinguish the crowded and non crowded area with the help of neural networks. It can be used to provide the crowd heat maps that can be used to determine the fly or no fly zone for the drone.^[8]

Some of the improvement that can be done to the existing system can be: The examination of the land area that is needed to constructed need to be examined that can be done by the proposed system. The examination of the land done before the

construction can be proved to be helpful as it can determine whether the land is suitable for construction or it is not. The other use of the proposed system can be in the surveillance of the workers in the construction sites. At the construction sites especially at the area where the construction is hazardous, workers face many problems at sites so the drone can be beneficial in monitoring the needs of the workers and maintaining the record of work done by the workers. The proposed system would not only help in the surveillance system but also help in the keeping the record of the workers through the images stored in the database but also make ensure that no mishappening takes place.

III. PROPOSED SYSTEM DESIGN

DRONE Modules

The DRONE which is basically a quadcopter consists of various components that are controlled by Arduino Uno chip that helps to make connections with different components through its IDE. Some of the common modules of quadcopter are:

1) Frame

A frame is the structure that is basically the main component of the quadcopter. It is responsible for holding all parts together and provides the structure and design to the drone. There are varieties of frames option available and it is up to the designer to select frame as per requirements. The frame selected for frame should be rigid and strong so that it is able to withstand the weight of other parts. The frame of the quadcopter consists of a center plate and four arms where on each arm four motors are placed and on the center the battery is placed to which the motor is connected.

Most of the frames are made up of carbon fiber which provides them rigidity and is also light weight. The carbon fiber provides rigidity but at the other hand it is also expensive which makes aluminum more popular than carbon fiber which also provides rigidity

and are available at affordable price. A frame of quadcopter is shown in Figure 1.



Figure 1. A Quadcopter frame

2) Motors

The motors in quadcopters are generally used so that the propellers can be rotated and it can ultimately provide flight to the drone. In quadcopters generally brushless motors are used. The brushless motors are used because of their high efficiency and noiseless operation. A cylinder containing magnets is attached to the rotating shaft on the outer side. A common brushless motor used in quadcopter is shown in figure 2:



Figure 2. Brushless motor

The brushless motor used in the drone are more better and efficient than the DC motors as it has more spinning power and consumes less power as compared to the DC motors. The Electronic Speed Controller which is commonly ESC is used to control the brushless motors in the quadcopter. The brushless motors are differentiated according to their "KV rating". For making a quadcopter four brushless motors are required.

3) Propellers

On each of the four brushless motors there are propellers mounted. All the propellers mounted are not identical. The two motors which rotate in

clockwise direction have different set of propellers as compared to the brushless motor which rotate in the clockwise direction. The propellers for the drone are available for different sizes and colors. It depends on the user to select the size of the propeller for the drone.

4) ESC- Electronic Speed Controller

The Electronic Speed Controller used in quadcopter is used for two purposes:

- ✓ It acts as a circuit allowing both the motor and the receiver to be powered by single battery.
- ✓ It also takes the receiver and the flight control signal and apply them to correct motors.

A typical ESC used in the construction of quadcopter is shown in figure 3.



Figure 3. An ESC

As the brushless motors are multi phased that cannot be powered directly with the battery they require ESC to connect motors with battery. The ESC controller boards are not very expensive and provide a battery input and a three phase output for the motor.

5) Lithium Polymer Battery

The LiPo batteries are generally used in the quadcopters because of two main features: firstly the LiPo batteries are chargeable batteries that can be charged with the help of battery charger, Secondly the LiPo batteries are light weight batteries.

6) Battery Charger

The LiPo battery is usually a charged battery that is charged using its battery charger. Once the battery is fully charged it can make the drone fly continuously for more than 20 minutes.

7) Arduino

An Arduino is often called the brain of the quadcopter. It is the component that controls the quadcopter. The Arduino is open source software that is used to control the components of quadcopter by writing program in C language in its IDE. It is responsible for connecting all the components in the quadcopter. The Arduino board consists of variety of microprocessors and controllers. The Arduino used in this project is Arduino Uno.

8) Transmitter and Receiver

The drone is controlled by a transmitter and receiver. The transmitter and receiver is generally used in the KUNO as it provides the feasibility for the user. The RC transmitter is the most commonly used transmitter. Along with the transmitter there is also a receiver that receives the signals transmitted by the transmitter. The transmitter is a hand held device that is used to control the quadcopter. The transmitter has two sticks, two trim buttons, switch and a power button. Mostly the transmitter consists of 4 channels that are used to control pitch, roll, throttle and yaw of the quadcopter and the transmitter is operated on a frequency of: 72 MHz and 2.4 GHz. A transmitter used to control the quadcopter is shown in figure 4:



Figure 4. A Transmitter and a Receiver

9) MPU 6050

The MPU 6050 contains an accelerometer and MEMS gyro in a single chip. It is a 16 bits analog to digital conversion hardware for each channel. It uses x, y, and z channel at the same time. It consists of 1024 byte FIFO buffer. If the MPU 6050 places the data in FIFO buffer it signals the Arduino with an interrupt

signal so that Arduino knows that there is data to be read in the buffer.

10) Additional Units:

a) Camera

The camera used in drone for surveillance which would be a phone camera (for initial stage) for providing video footage, and is accessible via mobile app.

b) 3D modeling Unit

The images taken by the drone would be used to convert into 3D models which could be helpful in getting the progress at construction site.

c) Digital Image Processing Unit

An important optional module that is used in drone is a Digital Image Processing unit. This unit will be used to analyze the image captured by the camera to the images stored in the database for the verification of the workers on the construction sites.

d) Facial Recognition

The facial recognition can be used to determine the exact information of the employees in the area and maintaining the records of each and every activity done by the worker.

e) Bar Code scanner

The bar code will be given to each and every person at the construction site which will be unique for all and the code will be linked to the aadhar QR code that can be helpful in verifying the details of the workers.

IV. PROPOSED SYSTEM

The construction of quadcopter using Arduino is a difficult task as it requires coding in Arduino Uno IDE in Objective C. Various other factors are also taken into account for the design and development of quadcopter.

The proposed system is that a quadcopter will be fitted with a camera which would be used for surveillance by applying facial recognition at construction sites and is

also used for generating 3D model of the construction sites.

The camera can later be added with digital image processing unit to examine the area whether it is suitable for construction or not. Furthermore, the drone can be added with features like using raspberry pi and GPS. GPS can be helpful in determining the exact location of drone whereas GPS and Wi-Fi can be attached to quadcopter with the addition of raspberry pi in the drone and using GPS navigation of the drone will become easy.

V. WORKING OF SYSTEM

The working of the system as depicted by the following steps:

Step 1: A land that is needed to be constructed is being scanned by the drone.

Step 2: The drone then takes a picture of the area it is flying over and applies digital image processing to generate 3D model of the construction site and compares the taken image with some templates stored in its database to analyze it.

Step 3: If the image captured by the drone is according to the Images as its templates then construction can be started and if the result is negative than construction is not allowed in that area.

Step 4: Once the construction is started the drone can be used as surveillance system by viewing the activity of various workers and making important announcements. This can be helpful in maintaining proper rules and regulations at construction sites. The drone also reduces the additional cost that company spends in hiring another employee just for surveillance at the construction.

Step 5: It can also be used to capture the images of the employees to mark their attendance by matching the taken images of the workers with images of the workers predefined in the database by applying facial recognition.

VI. SCHEMATICS OF DRONE

The drone which can be proved to be as a constructional aid because of variety of features it provide to the user. Some of the major applications of the drone are:

1. The quadcopter can be used as a surveillance system in the construction fields.
2. It can provide the analysis of the land whether it is suitable for construction.
3. It can provide surveillance in the area where it is difficult to survive for a human.
4. Attendance and announcements can be made easily.

The schematic of the drone is determined in the fig. 6. It consists of Arduino as the main component which connects all other components of the drone together. The four brushless motors along with four ESC and propellers are connected together and are controlled by the Arduino UNO. MPU 6050 serves the purpose of the gyro and accelerometer. These connections are made on the breadboard with the help of jump wires.

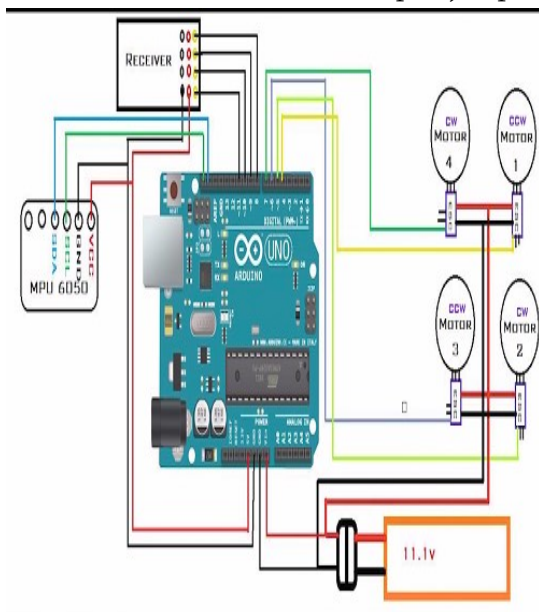


Figure 6. Schematic of Drone

VII. CODE OF DRONE

The code for drone is written in Objective C language and software used for the coding process is Arduino

IDE. The code for different parts is written differently and these written codes are uploaded on the Arduino UNO which acts as a brain of the quadcopter. The Arduino is responsible for controlling all the parts of the quadcopter and maintains a connection between all the components.

The code consists of importing the inbuilt libraries of MPU 6050. The MPU 6050 is an accelerometer and gyrometer that is used to provide stability to the quadcopter.

The code of Arduino consists of servo class that is used to control the motors of the quadcopter by measuring the input and output given to the motors. The servo motors have three wires which are power, ground and signal. The ground wire is typically black in color and is connected to the ground on the Arduino board. The power wire is red wire that is connected to +5V. The screenshot of code is shown in figure 7:



Figure 7. A snapshot of Arduino Code

VIII. GRAPHS RELATED TO VARIOUS MODULES OF DRONE

The analysis of the quadcopter depends on the efficiency of various parts of the quadcopter and the

relationship between them. A graph between different components of the quadcopter is shown below.

Throttle of drone is the motion of drone in the vertical up and down direction. Thrust of the drone can be defined as the force which moves the drone through the air. The variation in the propeller thrust and throttle position is shown in the figure 7

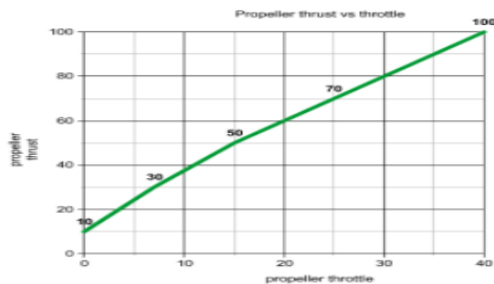


Figure 8. Thrust vs Percentage Throttle

The propeller efficiency can be defined as how efficiently the drone is. The variation in the propeller efficiency and throttle position of drone is determined in Figure 8.

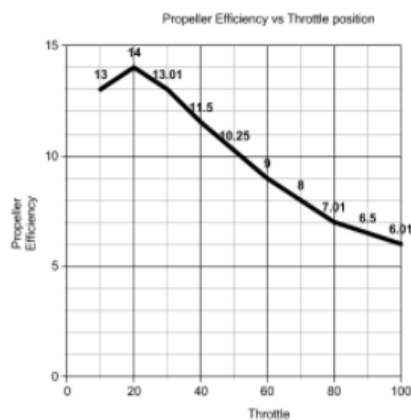


Figure 9. Propeller Efficiency vs Percentage Throttle

IX. CONCLUSION

Robotics is the field which is being slowly applied to each and every field as it reduces the cost and provides better efficiency. Due to its various advantages it has gained attention of various researchers. The Quadcopter can be used for other purposes such as detecting the quality of land and determining whether it is suitable for construction.

The proposed system can be used is in supplying the necessary items of the workers in the area where manual delivery is not possible.

Since Quadcopter is a field that is currently being researched and with the coming time it is going to replace all the manual work and would help to do work that is easily possible by humans.

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